Machine for Processing Foil

The invention relates to a sheet-processing machine according to the preamble of claim 1.

DE-B 10 44 589 describes a transverse-cutting arrangement for paper webs. A belt system for transporting the sheets cut from the web is arranged downstream of said transverse-cutting arrangement.

DE 42 38 387 A1 discloses a cut-off-register regulating arrangement on cross cutters of rotary printing machines. Provided in this case is a rotating cutting cylinder which interacts with a fixed mating blade.

The object of the invention is to provide a sheet-processing machine which makes it possible to cut individual sheets quickly and accurately transversely to the transporting direction.

This object is achieved according to the invention by the features of the defining part of claim 1.

The advantages which can be achieved by the invention consist, in particular, in that, in a sheet-processing machine, cross cutting at the start and end of a sheet and/or cutting of the previously formed longitudinal strips of a banknote sheet into individual banknotes take/takes place without manual intervention. By means of integrated inspection devices, it is possible, in the sheet-processing machine, to monitor both the print quality itself and the cut-off register. It is thus possible, at the same time, to monitor the front and rear sides of the sheet printed, for example, by face and reverse printing.

The interaction of the cross-cutting devices with a chain conveyor makes possible straightforward cut-off-register adjustment, which is advantageously carried out by a position-controlled electric motor which drives a cutting cylinder.

A longitudinal-cutting device may be assigned to a processing cylinder of the sheet-processing machine, with the result that the sheet is cut into two or more sub-sheets inline. These sheets may be set down on stacks which may be selected, for example, by means of the inspection device, i.e.

sorted stacks with satisfactory sheets and with reject sheets are formed. This has the advantage that, in the case of defective sub-sheets, it is not necessary for the entire sheet to be rejected.

Said sheet-processing machine can be used to trim all the sides of a sheet and to cut said sheet into sub-sheets. All the steps carried out as well as the face and reverse printing can be monitored by means of inspection devices and the sheets set down on selectable stacks.

Said sheet-processing machine can execute a number of processing operations inline, which results in an increase in production and in a reduction in manual work. In addition, the quality of the products produced in this way is increased.

Using an embodiment as claimed in claim 11, in particular, banknote sheets can be efficiently processed in a reliable manner to form individual banknotes.

Expedient further configurations of the invention can be gathered from the dependent claims.

The sheet-processing machine according to the invention and further embodiments are described in more detail hereinbelow and are illustrated in the drawing, in which:

Figure 1 shows a schematic side view of a sheet-processing machine;

Figure 2 shows a schematic illustration of the processing steps in the sheet-processing machine;

Figure 3 shows a schematic plan view of stacks of a delivery means of the sheet-processing machine;

Figure 4 shows an enlarged, schematic side view of a processing cylinder of the sheet-processing machine according to Figure 1;

Figure 5 shows an enlarged, schematic plan view of the processing cylinder of the sheet-processing machine according to Figures 1 and 4;

Figure 6 shows a second embodiment for processing banknote sheets;

Figure 7 shows an enlarged view of a cutting and separating station of the machine according to Figure 6;

Figure 8 shows a schematic illustration of the processing steps in the machine according to Figure 6; and

Figure 9 shows a schematic illustration of a third embodiment.

A sheet-processing machine 1 for the cross cutting and longitudinal cutting of sheets 2 has integrated inspection devices 3, 4, 6. The sheets 2 are preferably printed paper sheets, for example banknotes. Said sheet-processing machine 1 is constructed, for example, as follows:

A feeder 7 essentially has a first stack 8, a sheet-separating device 9 and a feed table 11. Said feeder 7 is adjoined by an abutting means 12 which is designed, for example, as a swing-action abutting means. A first chain conveyor 13 interacts with said swing-action abutting means 12. Said chain conveyor 13 has a pair of circulating chains 14 on which there are provided chain gripper systems, with grippers 16, extending transversely to the transporting direction. The chains 14 are deflected by a first chain-wheel shaft 17 and a second chain-wheel shaft 18. Between the first chain-wheel shaft 17 and second chain-wheel shaft 18, the chains 14 run at least partially along a straight line. The first inspection device 3 is arranged downstream of the first chain-wheel shaft 17, as seen in the transporting direction T. Said inspection device 3 has a suction box 19, of which the operating surface directed toward the chain gripper systems is of at least partially transparent design. Lighting devices (not illustrated) are arranged beneath said transparent operating surface.

A first cross-cutting device 21 is arranged downstream of said suction box 19. The cross-cutting device 21 has a rotating cutting cylinder 22 and a fixed mating blade 24 fastened on a crossmember 23. The cutting cylinder 22 is provided at least with an axially extending groove, it being possible for a passing chain gripper system with the gripper 16 to penetrate into the same. A width of the groove in the circumferential direction is designed to be larger than a width required by the chain gripper system, with the result that, for cut-off-register adjustment, the passing chain gripper systems, with the grippers 16 and the cutting cylinder 22 can be phase-shifted in relation to one another. In the present example, rotating arms are provided on both sides, and arranged between these is a crossmember which extends transversely to the transporting direction and is intended for

receiving a cutting blade 26. The cutting cylinder 22 has a drive which can be phase-adjusted in relation to the chain conveyor 13 and, in the present example, is advantageously designed as the dedicated, position-controlled electric motor. The mating blade 24 is arranged in a slightly oblique position in relation to the axis of rotation of the cutting cylinder 22, i.e. the mating blade 24 encloses, with the transporting direction T, an opening angle alpha other than 90°, for example 89°. This gives, for example, an angle of inclination of the mating blade 24 in relation to the axis of rotation of the cutting cylinder 22 of 1°. In addition, the mating blade 24 is rotated slightly about its longitudinal axis, i.e. the mating blade 24 has a slight twist.

The electric drive of the cutting cylinder 22 follows the chain conveyor 13 at identical circumferential speed, with the result that, ultimately, by twist and coinciding transporting speed, a precisely right-angled cut of the sheet 2 is produced.

The axially extending cutting blade 26 of the cutting cylinder 22 is inclined slightly in relation to the axis of rotation of the cutting cylinder 22 and has a twist in the longitudinal direction. The cutting blade 26 of the cutting cylinder 22 and the mating blade 24 are adapted to one another.

Instead of the fixed mating blade 24, it is also possible to have a rotating mating cylinder which has, for example, a mating blade 24, for executing a scissors cut, or a mating bar. It is also possible for the cutting blade 26 and mating blade 24 to be designed parallel to the axis of rotation of the cutting cylinder 22 and without any twist. The cutting cylinder 22 or mating cylinder may also have a plurality of cutting blades 26.

alt. not shown

In the region of the chain conveyor 13, a second inspection device 4 is arranged downstream of said cross-cutting device 21. Said second inspection device 4 essentially comprises a sensor 27, lighting devices 30 and a suction box 35.

The chain conveyor 13 is adjoined by a turning device 28. In the present example, said turning device 28 essentially comprises a storage drum 29 and a turning drum 31. The storage drum 29 has a "double" circumference for receiving two sheets and is thus equipped with two controllable gripper systems 32, which are offset through 180° in relation to one another, and two mutually opposite sucker systems 33. A spacing in the

circumferential direction between the gripper systems 32 and sucker systems 33 can be adjusted to a length of the sheets 2 which are to be transported. The sucker systems 33 can be moved in the circumferential direction and in the axial direction.

The turning drum 31 has two controllable gripper systems 34, 36 which are located one beside the other and are arranged such that they can be pivoted about their longitudinal axis.

The turning drum 31 and storage drum 29 can be phase-adjusted in relation to one another.

A processing cylinder 37 with an interacting longitudinal-cutting device 38 is arranged downstream of the turning device 28. Said processing cylinder 37 has at least a double circumference for receiving at least two sheets and four gripper systems 39, 41, 42, 43 which can be controlled independently of one another. Two of these gripper systems 39, 41 and 42, 43 are located, in each case in the axial direction, in relation to a center of the processing cylinder 37, more or less axis-symmetrically one beside the other in a cylinder groove and can be displaced in the axial direction relative to one another. In the present example, one of the two gripper systems 39 and 42 located axially one beside the other is fixed in the axial direction and the second gripper system 41 or 43 can be displaced relative to the first gripper system 39 or 42, for example, by means of a cam 40 and cam rollers 45. However, it is also possible for both gripper systems 39; 41 and 42; 43 to be displaceable. A first pair of two gripper systems 39, 41 configured in this way has a second pair of said gripper systems 42, 43 offset through 180° opposite it.

The longitudinal-cutting device 38, assigned to the processing cylinder 37, with a plurality of cutting wheels 44 is arranged a short distance downstream of the turning drum 31, as seen in the sheet-transporting direction T. In the present example, said longitudinal-cutting device 38 has a crossmember 46 which extends transversely to the transporting direction and on which there are arranged three axially displaceable cutting wheels 44 which can be actuated independently.

Arranged downstream of the processing cylinder 37 is a second chain conveyor 47 with two circulating chains 48 which have a plurality of

chain gripper systems with grippers 49. Said chain gripper systems comprise two chain gripper arrangements which are located one beside the other in the axial direction, that is to say transversely to the transporting direction, and are arranged more or less symmetrically in relation to the machine center and can be actuated independently of one another. Instead of the processing cylinder 37, it is also possible for the chain conveyor 47 to have chain gripper systems which can be moved relative to one another in the axial direction.

It is also possible for more than two gripper systems 39; 41 and 42; 43, i.e. any desired number, to be displaceable. In the case of three gripper systems arranged axially one beside the other, it would be possible, for example, for the gripper system arranged in the center to be stationary in the axial direction and for the outer two gripper systems to be capable of being pushed away from the central one.

The chains 48 are deflected by a first and a second chain-wheel shaft 51, 52. A center-to-center line 53 formed by the first chain-wheel shaft 51 and processing cylinder 37, or a connecting line between these parts, encloses, with a center-to-center line 54 formed by the processing cylinder 37 and the cutting wheels 44, an opening angle beta of less than 180°, e.g. 155°.

In the chain conveyor 47, beneath the chain 48, a suction box 56 is arranged downstream of said chain-wheel shaft 51. Said suction box 56 is adjoined by a second cross-cutting device 57, which is of the same structural design as the first cross-cutting device 21. A third inspection device 6 with a sensor 58, lighting devices 59 and a suction box 61 is arranged downstream of said second cross-cutting device 57.

Thereafter, a delivery means 62 is located in the region of the chain conveyor 47. Said delivery means 62 has six stacks 63, 64, 66-69, of which in each case two are arranged in pairs one beside the other and the resulting three pairs of stacks 63, 64 and 66, 67 and 68, 69 are arranged one behind the other. The stacks 63, 64 and 66, 67, arranged one beside the other, of the first two pairs of stacks each have common lifting devices, with the result that in each case one pair of stacks is raised and lowered together. In the case of the third pair of stacks, separate lifting devices are provided

for the two stacks 67, 68 located one beside the other, with the result that the two stacks 67, 68 can be raised and lowered independently of one another.

Gripper systems or chain gripper systems are to be understood as a plurality of grippers which are arranged on a shaft which can be pivoted about a longitudinal axis.

The sheet-processing machine 1 functions as follows:

A sheet 2, in particular a paper sheet printed by face and reverse printing, is fed from the first stack 8 to the feed table 11 by means of the sheet-separating device 9. From said feed table 11, the sheet 2 is gripped by the swing-action abutting means 12 and, in the region of the first chain-wheel shaft 17 of the first chain conveyor 13, transferred to the grippers 16 of a chain gripper system. Said chain gripper system grips the leading sheet end and transports the sheet 2 along the rectilinear part of the chain conveyor 13 to the first inspection device 3. By means of the first inspection device 3, the sheet 2 is examined segment by segment for damage, e.g. tears and holes. The watermark of the sheet 2 is also inspected by means of transmitted light. In this case, the sheet 2 is guided by the suction box 19 of the first inspection device 3, said suction box being subjected to the action of negative pressure. The chain gripper system transports the sheet 2 through the cross-cutting device 21 to the second inspection device 4. There, the sheet 2 is attached by suction, in the region of the start 71 of the sheet 2, by the suction box 35 of the second inspection device 4. The end 72 of the sheet 2 is still located in the cross-cutting device 21, in which a narrow strip 73, which extends axially and transversely to the transporting direction, is cut off from said end 72. In this case, the transporting speed of the chain conveyor 13 and circumferential speed of the cutting cylinder 26 are adapted to one another, with the result that the end 72 of the sheet 2 is trimmed at right angles to the transporting direction T.

Said sheet 2, which has a first cut 74, is then inspected by the second inspecting device 4. In this case, a front side (face-printing side) of the sheet 2 and a new edge of the sheet 2 (cut-off register) resulting from the trimmed end 72 are monitored.

The grippers 16 of the chain gripper system then transfer said sheet 2, by way of its start 71, to a gripper system of the storage drum. Said

storage drum 29 transports the sheet 2 in the direction of the turning drum 31. When the end 72 of said sheet then passes into the region of the sucker systems 33 of the storage drum 29, said sucker systems attach the trimmed end 72 by suction. Thereupon, the sucker systems 33 move away from the center of the storage drum 29 more or less in the form of an arrow and thus tension the sheet 2 both in the circumferential direction and in the direction of its lateral edges.

The phase shifting between the turning drum 31 and storage drum 29 is adjusted to the length of the sheets 2 which are to be processed. The storage drum 29 transports the start 71 of the sheet 2 through the gap between the turning drum 31 and storage drum 29 until the sucker systems 33 pass into said gap. The trimmed end 72 of the sheet 2 is gripped by the first grippers 34 of the turning drum 31 and released from the sucker systems 33 by virtue of the negative pressure being switched off. The grippers 34, 36 of the two gripper systems of the turning drum 31 then pivot toward one another, and the trimmed end 72 is transferred from the grippers 34 of the first gripper system to the grippers 36 of the second gripper system. As operation continues, the grippers 34, 36 pivot back into their original position.

As seen in the transporting direction T, the trimmed end 72, gripped by the grippers 36, leads and the untrimmed start 71 trails.

From the turning drum 31, the sheet 2 is transferred to a pair of gripper systems 39, 41 or 42, 43 of the processing cylinder 37. On the processing cylinder 37, the sheet 2 is provided with three cuts 76, 77, 78 in the longitudinal direction - that is to say in the transporting direction T. By means of the second and third cuts 76, 77, narrow strips 79, 81 are cut off from the two longitudinal sides of the sheet 2.

The gripper spacing of the gripper systems 39, 41, 42, 43 of the processing cylinder 37 and the width and position of the sheet 2 are adapted to one another such that the two cut-off strips 79, 81 are not gripped by grippers.

The fourth cut 78 separates the sheet 2 centrally into two sub-sheets 82, 83. It is also the case here that there is no gripper located in the region of the cut 78.

Once said three longitudinal cuts 76, 77, 78 have been completed, even in the case of the sheet 2 being of maximum length, the two sub-sheets 82, 83 are moved apart from one another in the axial direction. For this purpose, in the present example, a gripper system 41 or 43, or 39 or 42, executes a displacement in the axial direction by means of a cam roller which interacts with a cam. It is only once the two sub-sheets 82, 83 have been moved away from one another that said sub-sheets 82, 83 are transferred, in the region of the first chain-wheel shaft 51, to the grippers 49 of a chain gripper system of the second chain conveyor 47. The gripper system 41 or 43 of the processing cylinder 37 is moved back into its starting position before the next whole sheet 2 is received.

The two sub-sheets 82, 83 are fed to the second cross-cutting device 57 by said grippers 49. In order to steady the sheet 2, the latter is attached by suction along the suction box 56, which is arranged upstream of the cross-cutting device 57, and the end 72 of the sub-sheets 82, 83, said end being located in the grippers 49 of the chain gripper system, is already guided over the suction box 61 of the third inspection device 6. From the now trailing start 71 of the sheet 2, i.e. of the two drawn-apart sub-sheets 82, 83, a strip 86 is cut off by means of a fifth cut 84 in the axial direction at right angles to the transporting direction T. The sheet 2 has now been trimmed on all sides and separated into two sub-sheets 82, 83.

The rear side (reverse-printing side) of the sheet 2, i.e. the rear sides of the two sub-sheets 82, 83, is monitored, together with the longitudinally trimmed edges and the trailing start 71 of the sheet 2, i.e. the trailing, transversely trimmed ends of the sub-sheets 82, 83, by means of the inspection device 6.

From the inspection device 6, the chain conveyor 47 transports the sub-sheets 82, 83, which have been trimmed on all sides and monitored on the front and rear sides, to the six stacks 63, 64, 66-69 of the delivery means 62. There, the sub-sheets 82, 83 may be set down optionally on one of the six stacks 63, 64, 66-69. In this case, preferably the first four stacks 63, 64, 66, 67 receive so-called acceptable sheets and the last two stacks 67, 68, arranged one beside the other, receive reject sheets.

Figure 6 shows, schematically, the example of a sheet-processing machine which is designed for cutting banknote sheets, with a certain number of banknote prints, into individual banknotes and for transporting said banknotes away out of the main transporting path and, in the case of previously established misprints being present, for separating the latter from the satisfactory banknotes.

In the example considered, each banknote sheet 2, as is illustrated in Figure 8a, has eight banknote prints WD, which are arranged in matrix form in two columns S1 and S2, i.e. in two longitudinal rows, in relation to the transporting direction, and in four rows R1, R2, R3 and R4, i.e. in four transverse rows transverse to the transporting direction. As is indicated in Figure 6, said banknote sheets pass, for example by means of a chain conveyor 100, from a printing machine (not illustrated) into the sheet-processing machine in question here, which has, in succession, a transverse-cutting device 102, a longitudinal-cutting device 106 and an arrangement 111. In this arrangement 111, the longitudinal strips cut in the longitudinal-cutting device 106 are drawn along a main transporting path 114 at their front ends, by the grippers 113 of the chain gripper systems of a chain conveyor 112, and cut into individual banknotes in the process, said banknotes being transported away out of the main transporting path 114 and stacked separately into bundles corresponding to misprints and satisfactory banknotes.

The cross-cutting device 102 is of similar construction to the cross-cutting device 21 or 57 in the first exemplary embodiment according to Figure 1 and comprises a cutting cylinder 103 which, in this case, has two diametrically opposite cutting blades 104 which interact with a fixed mating blade 105.

The banknotes advanced by the chain conveyor 100 pass onto a sheet-transporting system which has a first transporting cylinder 101a as inlet cylinder, a second transporting cylinder 101b as outlet cylinder and a planar underlying surface 101 as transporting path which is located in the top tangential plane, common to the two transporting cylinders 101a and 101b, of said transporting cylinders and on which the banknote sheets are guided past the cross-cutting device 102 with sliding action. In the region of

the mating blade 105, the underlying surface 101 has a gap into which said mating blade projects. The spacing between the two transporting cylinders 101a and 101b is smaller than the length of a banknote sheet in the transporting direction, with the result that the leading sheet edge is gripped by the transporting cylinder 101b at a point in time at which the trailing region of the sheet is still retained on the circumference of the transporting cylinder 101a, and is carried along by the same.

The transporting cylinders 101a and 101b are preferably suction cylinders with suction openings, of which the suction-air feed is controlled such that the sheets are pushed onto the underlying surface 101, for example a metal plate, by the first transporting cylinder 101a and, after passing the cross-cutting device 102, are received by the second transporting cylinder 101b.

A banknote sheet is transported, and its two transverse edges trimmed, specifically as follows: a banknote sheet released by the grippers of the chain conveyor 100 is attached by suction to the first transporting cylinder 101a and carried along by the same until the leading sheet edge reaches the start of the underlying surface 101, which forms the transporting path. At this location, that is to say at the start of the underlying surface 101, the suction air is switched off, with the result that, as the transporting cylinder 101a rotates further, the sheet is pushed onto the underlying surface 101. As soon as the leading sheet edge reaches the cross-cutting device 102, the leading edge is trimmed by a cutting blade 104, while the sheet is advanced further until the trimmed leading edge reaches the second transporting cylinder 101b, which then receives the sheet, and draws it further, by attaching it by suction. This operation of the sheet being received by the transporting cylinder 101b takes place, as has already been mentioned, before the trailing end of the sheet leaves the first transporting cylinder 101a and is released by the same. While the trailing sheet end passes the cross-cutting device 102, the trailing sheet edge is trimmed by the other cutting blade 104, as is indicated in Figure 8b.

The sheets trimmed in this way then pass into the longitudinal-cutting device 106, which, in the example considered, has a transfer cylinder 107, which receives the sheet from the transporting cylinder 101b, a

processing cylinder 108 and cutting wheels 109 interacting therewith. The processing cylinder 108 and the cutting wheels 109 are constructed essentially in the same way as the processing cylinder 37 and the cutting wheels 44 of the longitudinal-cutting device 38 according to Figure 1, and will thus not be described in detail again. In said longitudinal-cutting device 106, the two longitudinal edges of the sheet are trimmed at the same time and the sheet is divided into longitudinal strips, in the example considered into two longitudinal strips L, which correspond to the two banknote columns S1 and S2, as is illustrated in Figure 8c. At the same time, as they pass the processing cylinder 108, the two longitudinal strips L are separated somewhat from one another, as has been described for the first exemplary embodiment.

From the processing cylinder 108, the longitudinal strips are received by the grippers 113 of the chain conveyor 112 and then run through the arrangement 111 for cutting and separating the individual banknotes. The longitudinal strips are drawn at their leading ends, by the grippers 113, onto the main transporting path 114, which is designed such that said continuously moving longitudinal strips, which are spaced apart one beside the other, are retained in a planar state.

The arrangement 111 has identically constructed cutting and separating stations 115 which are spaced apart one behind the other and of which the number is equal to the number of rows per banknote sheet minus one. Since, in the example considered, each banknote sheet 2 has four rows, three stations 115 are thus provided, the spacing between them being somewhat larger than the width of one banknote row, that is to say the dimension of the same in the transporting direction.

As is illustrated more accurately in Figure 7, each station 115 has a cross-cutting device 120, an endless transporting belt 124, which interacts therewith and is installed at a spacing above the main transporting path 114, parallel to the same, and two set-down tables 125 and 126 for the banknotes. Said cross-cutting device 120 has a cutting cylinder 121 with a cutting blade 122 which interacts with a fixed mating blade 123. Said mating blade 123 is arranged with its mount in a gap of the main transporting path 114. As far as the cutting function is concerned, the cross-cutting device 120 is constructed

essentially like the cross-cutting device 21 or 57 in the first exemplary embodiment according to Figure 1. However, the cutting cylinder 121 is additionally designed as a controllable suction cylinder which has suction openings (not illustrated) and secures the individual banknotes, produced following the cutting operation, by suction on the cylinder surface and conveys them to the transporting belt 124, a controllable suction belt, which receives said banknotes from the cutting cylinder 121.

The operation of cutting into individual banknotes and transporting the latter further in the arrangement 111 takes place as follows:

As soon as the longitudinal strips, which are spaced apart one beside the other and are drawn on the main transporting path 114 at their leading ends by the grippers 113 of the chain conveyor 112, reach the first cross-cutting unit 120 of the first station 115 with their trailing banknote prints, as seen in the transporting direction, the two trailing banknotes, corresponding to the original trailing transverse row R4 of the relevant banknote sheet, are cut off and conveyed by the continuously rotating cutting cylinder 121, which acts at the same time as the transporting cylinder, to the transporting belt 124.

While, in each station 115, a single cutting cylinder 121, interacting with a single mating blade 123, simultaneously cuts into individual banknotes all the longitudinal strips transported one beside the other, there are provided above the cutting cylinder 121 as many transporting belts 124 located one beside the other as there are longitudinal strips of a sheet, i.e. the number of transporting belts 124 arranged one beside the other is equal to the number of columns of a sheet. In the example considered, there are thus two transporting belts 124, located one beside the other, with corresponding set-down tables 125 and 126. The banknotes are attached by suction to, and released by, the cutting cylinder 121 by virtue of corresponding control of the suction-air feed, i.e. of the negative pressure to the suction openings of the cutting cylinder 121.

The suction action of the transporting belts 124 is controlled such that all the satisfactory banknotes are stacked on one set-down table 125 and all the misprints, which have been established in an earlier processing stage during quality control of the banknote sheets, are stacked on the other set-

down table 126. The misprints can be detected, for example, in a known manner by automatic sensing of the individual banknote prints on the banknote sheet and by electronic storage in a computer of all the positions of the banknote prints detected as misprints, the misprints being separated out by corresponding control of the suction action of the transporting belts 124 by the computer. All the misprints, which have been detected visually or electronically, may also be indicated by a marking which is sensed by a sensor which senses the relevant banknote prints or banknotes and of which the signal switches the suction action of the relevant transporting belt 124 on and off.

As soon as, once the trailing banknote prints of the original banknote row R4 have been cut off, the then trailing banknotes of the longitudinal strips, corresponding to the original banknote row R3, reach the second station 115, the banknotes of said original row R3 are cut off and, as has been described above, transported away and separated corresponding to misprints and satisfactory banknotes. This operation is repeated in the third station 115, in which the banknotes of the original banknote row R2 are cut and sorted. Of the longitudinal strips which are still drawn by the grippers 113 of the chain conveyor 112, it is then only the two banknotes corresponding to the original row R1 which remain, and these are received in the last station 116 by a suction roller 130 and fed to the two transporting belts 124 which, together with the set-down tables 125 and 126 for the misprints and the satisfactory banknotes, are of exactly the same construction as has been described above for a station 115.

Of course, the sheet-processing machine according to the invention can also be used to process banknote sheets which have 3 or more columns or longitudinal rows and any other desired number of transverse rows. The number of cutting and separating stations 115 which are to be arranged one behind the other is always equal to the number of transverse rows per banknote sheet minus one, followed by a last station 116 for the first transverse row of a sheet, as seen in the transporting direction in each case.

In the abovedescribed stations 115 and 116, all the satisfactory banknotes are successively stacked into bundles of 100 banknotes each

which had one and the same banknote position on the original successive banknote sheets of a sheet stack, that is to say in each case the positions with the same longitudinal and transverse rows, this resulting in a correct banknote sequence being formed. If, therefore, the numbering of the banknote prints on the banknote sheets has taken place in a conventional manner, that is to say if the banknote prints in the same banknote positions of successive sheets have been provided with consecutive numbering in each case and if, during the numbering, previously detected misprints have been missed out, then the banknote bundles formed contain banknotes with consecutive numbering. Such a numbering with numbering boxes controlled by a corresponding computer is known.

The abovedescribed arrangement 111 for cross cutting the longitudinal strips and for separating the individual banknotes may also be arranged downstream of the sheet-processing machine described with reference to Figure 1 in order, in the case of banknote sheets, to divide into individual banknotes the longitudinal strips produced there and to separate and bundle said banknotes.

Figure 9 shows, schematically, a further exemplary embodiment of a sheet-processing machine according to the invention. In this case, the banknote sheets 2 processed are printed with 35 banknote prints, which are arranged in five longitudinal rows and seven transverse rows and are moved in the direction of the arrows from one processing station to the next. The banknote prints WD on the sheets have previously been inspected visually or electronically for their quality, and the banknote prints detected as misprints WD' are marked with a cross in order to be separated out at a later stage.

The banknote sheets run first of all through a cross-cutting device, which may be constructed in the same way as the cross-cutting device 102 according to Figure 6 and in which the two transverse edges are cut off, as is indicated for the sheet 2a. The sheet then passes a first longitudinal-cutting device, which has two rotating cutting wheels and in which the two longitudinal edges are cut off, as is indicated for the sheet 2b. Then, in a second longitudinal-cutting device, with four rotating cutting wheels, the sheet is subdivided into five longitudinal strips, corresponding to the five longitudinal rows, as is indicated for the longitudinal strips 2c. Said

longitudinal-cutting devices correspond, in terms of construction, to the longitudinal-cutting device 106 according to Figure 6. During the longitudinal cut, the longitudinal strips are simultaneously, as has been described for the first two exemplary embodiments, moved away from one another somewhat in the transverse direction and then pass into an arrangement corresponding to the arrangement 111, where they are received by the grippers 113 of a chain conveyor, as in the example according to Figure 6. In this case, the arrangement has six cross-cutting devices 130 which are spaced apart one behind the other and of which the cutting cylinder and the fixed mating blade extend transversely over all the longitudinal strips and cut all the longitudinal strips simultaneously into individual banknotes. Said cross-cutting devices 130 are constructed in the same way as the cross-cutting devices 21 or 57 in the first exemplary embodiment according to Figure 1 and, in this case, do not serve for transporting away the banknotes which are produced.

As has been described with reference to Figure 6, first of all those banknotes of the five longitudinal strips which trail in the transporting direction, that is to say the trailing transverse row of the sheet, are cut off, then, at a discrete point in time, the banknotes of the following transverse row are cut off, etc., while in each case the remaining parts of all the longitudinal strips are drawn continuously by the grippers 113, which grip the leading end of said strips. Following the sixth cut, all that remains of the previous longitudinal strips is the foremost banknotes.

In this case, the cut banknotes are transported away, transverse row by transverse row, from the region of each cross-cutting device with the aid of a transporting system, for example a transporting belt, which is moved transversely to the transporting direction of the longitudinal strips, as is indicated schematically in Figure 9 by the arrows 131. From the grips of in each case five cut banknotes, which correspond to a transverse row of the original sheet, the marked misprints W' are then separated out, and collected, by a suitable separating-out device. In each case 100 successive satisfactory banknotes W which originate from the same transverse rows of successive sheets are stacked into a bundle, and this bundle B is banded. In the example considered, there are thus seven bundling stations for forming bundles B in

which banknotes originating in each case just from the same transverse rows of successive sheets, i.e. thus just from the first or just from the second or just from the seventh transverse rows of successive sheets, are located in the correct sequence.

The bundles B produced one after the other in each bundling station are stacked into stacked groups P, every second bundle being previously rotated in a known manner through 180° in the bundle plane in order that all the bands are not located one above the other in the stacked group P. As soon as a stacked group P comprises ten successive bundles, it is transported, as is indicated by arrows in Figure 9, to a stacked-group-banding station, where the stacked group, containing ten bundles each with a hundred banknotes in the correct sequence, is provided with a band. Said banded stacked group BP is then fed into a packaging station in a known manner, once the banknotes in the stacked group have been counted again.

As has been described above, and as can be seen from Figure 9, all the banded stacked groups BP thus each contain banknotes in the correct sequence in each case from the same transverse rows of the original successive sheets. In this case, the numbering of the banknote prints on the sheets may preferably be such that only the satisfactory banknote prints within each row are numbered consecutively, whereas the previously established misprints are missed out during numbering, as has been mentioned for the exemplary embodiment according to Figures 6 and 7. In this case, the stacked groups BP formed each have one thousand consecutively numbered banknotes.

The abovedescribed operations of forming, collecting and bundling individual banknotes in the correct sequence are made possible, in particular, by the abovedescribed cross-cutting devices, by means of which, with time delays, the previously formed longitudinal strips of a sheet are cut simultaneously, corresponding to the original transverse rows, into individual banknotes, the respectively remaining parts of the longitudinal strips being moved forward continuously, at their leading ends, by the grippers of a chain conveyor.